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The CH-53E helicopter is being developed to provide the Navy and the Marine Corps with a shipboard helicopter with greatly increased lift capability. It was intended to be a modified version of the CH-53D model; however, it now more closely resembles a new aircraft because of improvements incorporated during the development stage. The Navy expected to complete engineering development in November 1976 and to award a production contract in February 1977 for 10 aircraft. In August 1976 the Navy extended the research and development effort and deferred the procurement decision until January 1978.

Findings/Conclusions: The Navy's decision to extend research and development and to delay procurement of the CH-53E was appropriate. This change should provide sufficient time to fully develop and successfully test the aircraft prior to the full-scale production decision. The program restructure has also had an impact on the need for fiscal year 1978 procurement funds for the CH-53E. Recommendations: The Secretary of Defense should take the action necessary to make sure that needed improvements are fully developed and successfully tested prior to awarding the limited production contract and to minimize the Government's liability for purchase of long leadtime material. The Congress may wish to require a Selected Acquisition Report on this program. (Author/SC)

REPORT TO THE CONGRESS



*BY THE COMPTROLLER GENERAL
OF THE UNITED STATES*

Status Of The CH-53E Helicopter Program

Department of the Navy

The CH-53E helicopter is being developed to provide a shipboard helicopter with greatly increased lift capability.

Development effort was scheduled to be completed in November 1976 and fiscal year 1977 procurement funds were provided to purchase 10 aircraft. In August 1976 the Navy extended the research and development effort and deferred the procurement decision until January 1978.

The Congress and the Secretary of Defense should make sure that commitment of 1977 procurement funds is minimized until the aircraft is fully developed and successfully tested.



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-163058

To the President of the Senate and the
Speaker of the House of Representatives

This report presents our views of the major issues on the CH-53E Helicopter Program. For the past several years we have annually reported to the Congress on the status of selected major weapons systems. This report is one of a series of 29 reports that we are furnishing to the Congress for its use in reviewing fiscal year 1978 requests for funds.

A draft of this report was reviewed by agency officials associated with the program and their comments are incorporated as appropriate.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget, and the Secretary of Defense.

A handwritten signature in cursive script, reading "James A. Beards".

Comptroller General
of the United States

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ABBREVIATIONS

AFCS	Automatic Flight Control System
COMOPTEVFOR	Commander Operational Test and Evaluation Force
DOD	Department of Defense
DSARC	Defense Systems Acquisition Review Council
DTC	design-to-cost
FY	fiscal year
GAO	General Accounting Office
IR	infrared
OPTEVFOR	Operational Test and Evaluation Force
R&D	research and development
SAR	Selected Acquisition Report

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

STATUS OF THE CH-53E HELICOPTER
PROGRAM
Department of the Navy

D I G E S T

The CH-53E helicopter is being developed to provide the Navy and Marine Corps with a shipboard helicopter with greatly increased lift capability. It was intended to be a modified version of the CH-53D model, however, it now more closely resembles a new aircraft because of improvements incorporated during the development phase. (See pp. 1 and 8.)

The Navy expected to complete engineering development in November 1976 and to award a production contract in February 1977 for 10 aircraft. Plans were to request production funds annually through fiscal year 1980.

GAO's review of the CH-53E program centered on the recent decision to extend the research and development effort and plans to award a production contract.

The following important matters were noted:

- Navy and contractor testing disclosed that the Automatic Flight Control System was not operationally suitable and that a new transmission is needed to improve reliability and maintainability. (See p. 6.)
- Testing also disclosed several deficiencies that affect airworthiness, mission effectiveness, and safety. (See pp. 6, 7, and 8.)
- Parts commonality with the CH-53D has diminished to an extent where it has been decided to assign the CH-53E to independent squadrons for support rather than assigning them to existing CH-53D units. (See pp. 8 and 9.)

Tear Sheet. Upon removal, the report cover date should be noted hereon.

- In August 1976 the Navy restructured the CH-53E development program to allow for required additional development effort. The scheduled full-scale production decision milestone of November 1976 was canceled and replaced by a limited production decision planned for January 1978 and a full-scale production decision planned for August 1978. (See ch. 3.)
- Since September 1974 estimated program cost has increased over \$266 million (about 48 percent) to a total of \$815.8 million. Economic escalation and development of improvements were the primary causes of the cost increase. The program unit cost of CH-53E is now estimated at \$11 million. (See pp. 3, 4, and 5.)
- In September 1976 \$20 million of fiscal year 1977 procurement funds were reprogrammed for research and development to finance the extended development effort. (See p. 11.)
- Current plans provide for using \$33 million of fiscal year 1977 procurement funds to purchase long leadtime material prior to successful flight testing of the improved transmission and the new Automatic Flight Control System. The remaining \$62.6 million will not be needed until after the limited production decision planned for January 1978. (See p. 10.)

GAO believes the Navy's recent decision to extend research and development and delay procurement of the CH-53E was appropriate. This change should provide sufficient time to fully develop and successfully test the aircraft prior to the full-scale production decision. GAO also believes the program restructure has had an impact on the need for fiscal year 1978 procurement funds for the CH-53E.

GAO recommends that the Secretary of Defense take the action necessary to make sure that needed improvements are fully developed and successfully tested prior to awarding the limited production contract and to minimize the Government's liability for purchase of long leadtime material.

Due to the additional development effort and the delay in major decision milestones, the Congress may wish to require that a Selected Acquisition Report be submitted on this program.

A draft of this report was reviewed by agency officials associated with management of the program and their comments have been incorporated as appropriate.



CH-53E

(PHOTO COURTESY OF U.S. NAVY)

CHAPTER 1
INTRODUCTION

The CH-53E helicopter program is being developed to satisfy a Navy and Marine Corps requirement for a shipboard helicopter with greatly increased lift capability. Its mission includes the lift and movement of cargo; transport of troops/passengers; tactical recovery of downed or damaged aircraft, including retrieval of another CH-53E; lift of heavy, bulky equipment and supplies externally by cargo hook; and towing of craft and mine countermeasure devices.

The CH-53E helicopter is an outgrowth of the CH-53D, but is designed to lift over twice the payload while occupying only 1.1 times the deck or hangar space. They differ in the following major respects:

<u>CH-53E</u>	<u>CH-53D</u>
Three T-64-GE-415 engines	Two T-64-GE-413 engines
Seven main rotor blades--79 foot diameter	Six main rotor blades--72 foot diameter
Canted tail (20 degrees)-- 20 foot tail rotor diameter	Conventional tail--16 foot tail rotor diameter

The CH-53E program is presently in full-scale engineering development, which was initiated in May 1975. Sikorsky Aircraft Division of United Technologies Corporation, Stratford, Connecticut, has fabricated and tested two production prototype aircraft.

A Defense Systems Acquisition Review Council (DSARC) meeting was scheduled for June 1976 to decide whether to release long leadtime material funds for the CH-53E helicopter. However, the DSARC was not held. Instead, a program review was performed to assess progress and cost. On August 30, 1976, DOD approved a restructured CH-53E acquisition plan.

SCOPE OF REVIEW

We reviewed program documentation and interviewed Navy officials responsible for CH-53E program management and testing at the Project Office, Arlington, Virginia, and at the Operational Test and Evaluation Force (OPTEVFOR) headquarters in Norfolk, Virginia. We also interviewed contrac-

tor officials at Sikorsky Aircraft and reviewed records maintained by the development contractor at Stratford, Connecticut.

Our review primarily covered the development effort since our last report. It includes reported cost and schedule changes from September 30, 1974 through September 30, 1976.

CHAPTER 2

PROGRAM STATUS

The development phase of the CH-53E program has experienced cost growth and schedule slippage, and the program has recently been restructured. (See ch. 3.) Test results have disclosed that the preproduction prototypes are not operationally suitable at this time. A redesigned Automatic Flight Control System (AFCS) and transmission are required. Commonality with the CH-53D has been reduced to an extent where the CH-53E now resembles a new aircraft. The Navy did not receive production approval for the CH-53E by November 30, 1976, as they had previously planned.

Since September 30, 1974, estimated program costs have increased \$266.1 million with unit costs increasing from \$7.4 to \$11.0 million. Since program approval in May 1973 costs have increased \$238.2 million. The Design-to-Cost (DTC) goal has been exceeded, and a new goal will be established. The full-scale production decision was scheduled for November 1976, but it has been postponed until August 1978, a slip of 22 months. A limited production decision milestone for six aircraft is now scheduled for January 1978. Performance testing to date has demonstrated CH-53E capabilities, but some technical problems in addition to the AFCS and transmission are unresolved. (See pp. 6, 7, and 8.)

COST

The following table compares the estimates in certain Selected Acquisition Reports (SARs) from September 30, 1974, to June 30, 1976, and the restructured program of August 30, 1976.

	<u>Program cost estimates</u>			<u>Restructured program estimate</u>
	<u>9-30-74</u>	<u>9-30-75</u>	<u>6-30-76</u>	<u>8-30-76</u>
	<u>(millions)</u>			
Development	\$ 92.1	\$102.2	\$111.8	\$118.9
Procurement	<u>321.4</u>	<u>343.5</u>	<u>390.5</u>	<u>414.6</u>
Total in 1973 dollars	<u>\$413.5</u>	<u>\$445.7</u>	<u>\$502.3</u>	<u>\$533.5</u>
Provisions for economic escalation	<u>\$136.2</u>	<u>\$227.3</u>	<u>\$248.3</u>	<u>\$282.3</u>
Total program	<u>\$549.7</u>	<u>\$673.0</u>	<u>\$750.6</u>	<u>1/\$815.8</u>
Unit cost (4 preproduction and 70 production aircraft)	\$ 7.4	\$ 9.1	\$ 10.1	\$ 11.0

1/The September 30, 1976 SAR estimate is \$816.6 million.

The total program cost estimate increased \$266.1 million or 48 percent from September 30, 1974, to August 30, 1976. The increase consists of \$200.9 million from September 30, 1974, to June 30, 1976, with the remaining \$65.2 million attributable to program restructuring.

The cost increase of \$200.9 million from September 30, 1974, to June 30, 1976, was due primarily to economic escalation. The development program increase reflects increased requirements for the new transmission, a digital automatic flight control system, and other improvements. (See p. 10.) Other cost increases include:

--Increase in support costs, including peculiar ground support equipment to reflect reduced CH-53D/E commonality.

- Increases in engine prices.
- Increase in the estimated cost of spare parts.
- Addition of devices to carry auxiliary fuel tanks.
- Increase in cost estimates for publications, technical data, and factory training.

On May 14, 1975, a DTC goal of \$4.36 million on 1973 dollars was established as the average unit flyaway cost. The current average unit flyaway cost estimate is \$4.75 million in 1973 dollars. The Project Manager for the CH-53E helicopter said that a new DTC goal will be incorporated in the Decision Coordinating Paper scheduled to be completed in the near future.

SCHEDULE

Since September 30, 1974, key program milestones have slipped another year, a total of 2 years slippage since program inception. Much of this delay has been the result of program restructuring. (See ch. 3.) However, factors not related to the recent program action have also caused delays.

The program was lengthened after a ground accident destroyed one of the developmental prototypes. The accident led to a delay in DSARC action and contributed to subsequent slippages. The Navy had to equip the other prototype with test equipment which delayed anticipated completion of full-scale engineering development.

PERFORMANCE

Operational and technical performance characteristics have changed little since September 30, 1974. However, the results of tests performed to date indicate the following potential problems.

Testing results

During development, Sikorsky performed studies of potential configuration changes. Studies were completed on the automatic flight control system and transmission and the results were submitted to the Navy in June and July 1974. The results indicated the desirability of improvements, especially in the area of reliability/maintainability.

Project Office officials advised us that the decision to use an uprated transmission was made early in the program, but funds were not available for its development. Project Office officials initially believed that they could solve the problems with the existing analog AFCS.

Testing completed in February 1975 disclosed problems with the AFCS and the transmission. Specifically, flight handling qualities were not adequate and the test report suggested modifications to AFCS. Nose high attitudes on approaches to hover were causing high levels of stress on the main rotor shaft reducing its useful life to unacceptable levels. In addition, the transmission could not absorb full engine power without reducing the life of transmission components.

The OPTEVFOR test report, dated May 21, 1976, cites the potential for operational effectiveness and suitability, but notes the need to correct existing deficiencies. Consequently, the report recommends continuation of CH-53E development and testing and correction of deficiencies prior to full production commitment. According to the OPTEVFOR Commander (COMOPTEVFOR), the high failure rate and level of maintenance effort required for the present analog AFCS render the CH-53E operationally unsuitable at the present time. The new transmission is needed to increase the time between overhaul and is expected to lower cost of ownership. The restructured program provides for Sikorsky to perform ground and flight testing on both the digital AFCS and the transmission.

Risk considerations

CH-53E testing has also disclosed technical deficiencies, most of which were resolved in subsequent tests and evaluations. However, several deficiencies persist that are serious enough to have an impact on the:

- Airworthiness of the aircraft.
- Ability of the aircraft to accomplish its primary and secondary missions.
- Safety of the crew, where likelihood of injury or damage exists.
- Effectiveness of the crew.

Severe structural vibration with internal loads at certain centers of gravity

In June 1976 Sikorsky test pilots experienced structural vibrations at less than maximum speed when carrying internal loads with a forward center of gravity. Unless the pilot slows the aircraft, these vibrations become increasingly severe and could result in destruction of the aircraft. As a result, the Navy limited airspeed to 150 knots during the recently completed Navy evaluation. A similar limitation has been imposed during testing that began in November 1976. We were advised that two proposed approaches to resolve this problem are underway and testing will begin in January 1977.

Static discharge not eliminated

The Navy has not been able to eliminate a static charge buildup in the CH-53E aircraft except by physically grounding the aircraft. The electrical discharge is potentially fatal to ground personnel who grasp the cargo hook before the aircraft can ground itself. An operational evaluation noted that the lack of a satisfactory active static discharge system poses a safety hazard to the hookup crew and makes external load missions operationally unacceptable. However, a passive discharge procedure of grounding the aircraft using a steel rod with copper contacts has been prescribed to protect personnel. We were told that an active aircraft mounted discharge system is under development.

Downwash velocities

Operational testing disclosed that the extreme downwash and gust velocities of the CH-53E when hovering with maximum load prohibit troop movement and may result in:

- Personnel exposed to downwash not being able to perform normal duties.
- Damage to blades and control surfaces of nearby aircraft during shipboard operations.

We were told that operational procedures have been effective in reducing this problem for operations over relatively unconfined land areas.

Because the CH-53E has not yet undergone shipboard testing, the significance of the problem is unknown at this time. Shipboard testing is scheduled to begin in January 1977.

Structural damage to rotor blades caused by gas impingement by engine and auxiliary powerplant

Blade damage occurs when high temperature exhaust gases impinge on the inboard third of the blade length while the rotor is stationary. The adverse effect on the main rotor blades can result in increased maintenance workload and reduced availability in addition to degradation in the structural integrity and safety of the aircraft. The problem occurs if the main rotor blades are not properly positioned prior to starting the auxiliary power plant or the number two engine. According to the Project Manager, the problem was resolved in October 1976 by installing a special duct and providing for automatic repositioning of rotor blades prior to engine start.

COMMONALITY WITH THE CH-53D

The CH-53E acquisition program was "sold" as a low risk program that would benefit from an estimated 60 percent commonality with the CH-53D helicopter. The CH-53D/E commonality of parts would reduce development risk and secure operational cost benefits.

The CH-53E has undergone design changes during development and now more closely resembles a new aircraft, rather than a modified CH-53D. In addition to the digital AFCS and uprated transmission, the CH-53E will have new rotor blades, infrared (IR) suppressor, crashworthy fuel system, rear fuselage folding system, two-point suspension system, force augmentation system, horizontal stabilizer, and auxiliary powerplant clutch system, plus landing gear improvements and a reinforced fuselage and tail pylon.

The project manager said that many actions which have reduced commonality with the CH-53D aircraft were taken to improve reliability and maintainability.

The OPTEVFOR report states that the CH-53E is essentially a new aircraft with unique maintenance logistics requirements and concludes that:

"* * * the plan to minimize personnel, training, and logistics support problems through CH-53D/CH-53E commonality appears unachievable unless CH-53E design is altered significantly. Since

this is unlikely, the effort of assigning the CH-53E to existing CH/RH-53D units requires reassessment, to ensure resources are on hand to adequately support both versions."

The reduced commonality between the CH-53D and CH-53E has contributed to increased acquisition cost. As presently configured, the CH-53E imposes different training requirements than those required for CH-53D maintenance support personnel. According to the COMOPTEVFOR, training costs for the CH-53E will not be known until completion of the Operational Evaluation, scheduled for April 1978.

CHAPTER 3

PROGRAM RESTRUCTURE

In August 1976 the Navy restructured the CH-53E program to overcome problems encountered during development. The primary changes resulting from this action were:

- Research and development (R&D) was extended 10 months primarily to provide for further development test and evaluation of an uprated transmission and digital AFCS.
- Estimated R&D costs increased \$20 million and total program costs increased a total of \$65 million.
- The CH-53E planned procurement was extended 1 year, the delivery schedule was also extended, and the number of aircraft to be procured with fiscal year (FY) 1977 funds was reduced from 10 to 6.

EXTENSION OF DEVELOPMENT

The R&D program was extended 10 months from March 1977 to January 1978 to complete development effort, especially for the uprated transmission and digital AFCS, prior to a decision for limited production of six aircraft. Fiscal year 1977 procurement funds which totaled \$95.6 million will purchase six aircraft. Current plans call for \$33 million of these funds to be released in April 1977 to provide for long lead items. The remainder will be for the six helicopters and is scheduled to be awarded after the DSARC review in January 1978.

The restructured CH-53E program provides for Sikorsky to perform ground and flight testing of the new transmission and digital AFCS. Testing milestones are scheduled for completion after the anticipated date for obligation of FY 1977 funds for long leadtime material. According to COMOPTEVFOR, this is the critical milestone for production commitment.

The improved transmission will undergo 300 hours of ground testing prior to installation in the production prototype aircraft. The Navy believes this is adequate to demonstrate the successful development of the transmission. A Military Qualification Test is scheduled during the first quarter of fiscal year 1978. Flight testing to assess flight handling qualities and structural integrity is scheduled from May or June 1977 through February 1978. The digital AFCS is scheduled for evaluation in November 1977

and the reliability demonstration is scheduled for completion in December 1977. Because long leadtime funding for material is scheduled for April 1977, the Navy will not have conducted flight tests that demonstrate performance of the transmission and digital AFCS until after long leadtime funds have been committed.

To fund the additional development requirements, the Navy obtained Congressional approval in September 1976 to reprogram \$20 million of FY 1977 procurement funds to support the planned development effort.

The following shows the intended use of the \$20 million.

Automatic Flight Control System (\$6.0 million)

The CH-53E prototypes have an analog computer system that is a version of the AFCS presently on the CH-53D helicopter. CH-53E testing disclosed problems that led to the requirement for a digital AFCS. The cost is for design, fabrication, installation, and test of a digital AFCS to replace the analog AFCS currently on the CH-53E prototypes.

Improved transmission (\$2.8 million)

This is the cost of installing an updated transmission in the production prototype aircraft for further testing.

Crashworthy fuel system (\$2.3 million)

This added requirement is for safety purposes to prevent post crash fires and thermal casualties. It provides fuel tanks which will not rupture, fuel lines which seal if broken, and other features to prevent fuel spillage in the event of a crash.

IR suppression (\$1.6 million)

This cost is for the development of IR suppression devices to diffuse the heat from engines and reduce the exhaust plume to counter heat-seeking missiles. Such devices improve combat survivability. The CH-53D suppressor is not adequate to cope with the heat and plume generated by the CH-53E engines.

Fatigue testing (\$1.6 million)

This is an added requirement for fuselage fatigue testing. The last phase will include stresses applied to the breaking point.

Development contract cost growth (\$4.8 million)

The cost of completing the definitized portion of the full-scale development contract increased when a rotor vibration problem caused delays in further testing. (See p. 7.) In addition, redesign of the tail rotor pylon and horizontal stabilizer became necessary when Navy testing results disclosed nose-up attitudes during approach to hover that required excessive pilot control actions to overcome. This redesign effort delayed completion of the aircraft and initiation of contractor flight testing.

Other (\$0.9 million)

The remaining \$0.9 million is for development of a two-point suspension (two cargo hooks rather than one for increased load stability), auxiliary fuel tanks, peculiar ground support equipment, and in-house testing.

IMPACT ON PROGRAM COST

As a result of the restructuring, estimated acquisition costs have increased from \$750.6 million to \$815.8 million. The \$65.2 million cost increase is comprised of the following.

	(millions)
Escalation due to program stretchout	\$34.0
Increase in airframe costs	26.7
Increase in engine prices	7.8
Increase in initial spares	6.8
Reduction in support requirements	(9.8)
Reduction in Government-furnished equipment	<u>(0.3)</u>
	<u>\$65.2</u>

EXTENSION OF AIRCRAFT DELIVERY SCHEDULE

The scheduled full-scale production decision milestone of November 1976 was canceled and replaced by a limited production decision to be made in January 1978 and full-scale production decision to be made in August 1978, a slip of

22 months. As shown below, the FY 1977 planned procurement of 10 CH-53E aircraft has been reduced to 6, and the program has been extended an additional year due to the restructuring.

<u>FY</u>	<u>Procurement schedule</u>	
	<u>Before restructure</u>	<u>After restructure</u>
1977	10	6
1978	16	12
1979	20	16
1980	24	18
1981	--	18
Total	<u>70</u> --	<u>70</u> --

Estimated deliveries of the production aircraft have been revised as follows.

<u>FY</u>	<u>Delivery schedule</u>	
	<u>Before restructure</u>	<u>After restructure</u>
1978	3	-
1979	12	6
1980	19	12
1981	22	16
1982	14	18
1983	--	18
Total	<u>70</u> --	<u>70</u> --

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Development of the CH-53E helicopter is not complete, and \$20 million of FY 1977 procurement funds was reprogramed to finance the additional development effort. A digital AFCS is being developed because the current AFCS requires unacceptable levels of maintenance and is not operationally suitable. The new transmission is needed to improve reliability and maintainability and is expected to lower operating costs. Testing has also disclosed technical deficiencies that affect airworthiness, mission effectiveness, and safety. Planned parts commonality has been reduced to the point where the CH-53E more nearly resembles a new aircraft rather than a growth version of the CH-53D, thereby increasing development effort.

As a result of the problems disclosed during the testing and program reviews, the program was restructured on August 30, 1976, increasing estimated program costs by a total of \$65 million. The production decision, previously scheduled for November 1976, has been redefined and now provides for a possible limited procurement decision for 6 aircraft by January 1978, with a decision for full-scale production of the remaining 64 aircraft by August 1978. Aircraft deliveries have been extended 1 year into FY 1983.

Obligation of FY 1977 procurement funds for long lead-time material is scheduled for April 1977, a critical milestone for production commitment. However, flight testing of the digital AFCS and improved transmission will not have been conducted at that time. As a result, the Navy will not have demonstrated performance at the time FY 1977 procurement funds are scheduled for obligation for long leadtime material.

In view of the significance of the problems disclosed in our review, we recommend that the Secretary of Defense make sure that improvements are fully developed and successfully tested prior to awarding the limited production contract and to minimize the Government's liability for purchase of long leadtime material.

Due to the additional development effort and the delay in major decision milestones, the Congress may wish to require that a Selected Acquisition Report be submitted on this program.